CORNELL SOIL HEALTH TEST: NEW GUIDELINES, PACKAGES OF TESTS, EASIER INTERPRETATION

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Declining soil health is an emerging issue of global concern because degraded soils are becoming more prevalent due to intensive use and degrading management practices of our soils everywhere. Also, such soils are less resilient to more extreme temperatures and precipitation events brought on by climate change. As agronomically essential soil functions and processes are degraded, this significantly impacts agricultural productivity as well as the environmental sustainability of agriculture.

Standard chemical soil analysis has been hugely successful in helping growers manage nutrient constraints to cropping, but physical and biological soil constraints that impact crops have been largely ignored by soil testing services. The Cornell Soil Health Test (CSHT) was developed in NY State (NYS) for use in the Northeast over the last years in response to increasing concerns from growers: compaction, disease pressure, lacking resilience to droughts and intense rainfall, loss of organic matter, surface crusting, erosion, increasing inputs with stagnant or declining yields and other problems are common on NYS farms. The CSHT measures, rates and interprets an integrative set of 15 physical, biological, and chemical indicators that represent agronomically important soil processes. Growers receive a color-coded report that provides information about which soil processes are constrained. The grower can then adapt soil management to specifically target management strategies at alleviating identified constraints.

Several developments by the Cornell Soil Health Team will be discussed:

1. The Cornell Soil Health Report – what does it all mean?
2. A four-step process to guide management decisions based on a CSHT report
3. Relationship of CSHT measures to yield in Kenya
4. Sample submission in 2011
5. Training, manual, other resources

1. The Cornell Soil Health Report – what does it all mean?

The CSHT identifies constraints in agronomically essential soil processes by using scoring functions (explained in our manual) to rate measured indicator values. A lower rating means the process is functioning less well. The rating system is as follows: Each measured value receives a rating

CORNELL SOIL HEALTH TEST REPORT (COMPREHENSIVE)

Name of Farmer: Willsboro Farm	Sample ID: E128
Location: Sayward Rd. Willsboro NY 12296	Agent: Bob Schindelbeck, Cornell University
Field/Treatment: TILL 3A	Agent's Email: 0
Tillage: 7-9 INCHES	Given Soil Texture: CLAY
Crops Grown: COG/COG/COG	Date Sampled: 4/25/2007

	Indicators	Value	Rating	Constraint
PHYSICAL	Aggregate Stability (%)	12	3	aeration, infiltration, rooting
	Available Water Capacity (m/m)	0.17	43	
	Surface Hardness (psi)	57	91	
	Subsurface Hardness (psi)	200	82	
BIOLOGICAL	Organic Matter (%)	3.3	25	energy storage, C sequestration, water retention
	Active Carbon (ppm) [Permanganate Oxidizable]	559	20	Soil Biological Activity
	Potentially Mineralizable Nitrogen (µgN/ gdwsoil/week)	4.8	0	N Supply Capacity
	Root Health Rating (1-9)	2.5	88	
CHEMICAL	*pH	6.1	67	
	*Extractable Phosphorus (ppm) [Value <3.5 or >21.5 are downscored]	2.5	44	
	*Extractable Potassium (ppm)	83	100	
	*Minor Elements		100	
	OVERALL QUALITY SCORE (OUT OF 100):		55.3	Medium

Figure 1. Cornell Soil Health Test Report (usually in color), showing constraints (Rating < 30, in red) in a long-term moldboard-plowed corn grain field.

from 0-100 (<30 is constrained). Scores of 70 and above indicate optimal functioning of the soil (in green), while medium scores (>30, but <70, in yellow) indicate marginal functioning. The Overall Quality Score given at the bottom of a report is an average of all indicator ratings. The constraints column shows the soil processes that are constrained when the indicator rating is red.

2. Four-Step Process to Guide Management Decisions Based on a CSHT Report

A key concept in soil health assessment is that indicators measured in the CSHT represent how well agronomically important soil processes are functioning in the soil. For example, when aggregate stability receives a low rating (Fig. 1), this means that soil crumbs fall apart easily in the rain, and this means that aeration, infiltration, and shallow rooting are constrained, and that surface crusting and erosion problems are likely.

The question then is – what can a grower do to alleviate such a problem? It is important to understand that a CSHT report is a guide to management, rather than a prescription (such as nutrient recommendations), because soil health constraints generally require a more integrated approach, and because there are usually many different management approaches that can mitigate the same problem. Also one management practice can affect multiple indicators. What works on one farm and cropping system is not necessarily feasible or ideal in another, and so report information must be adapted situationally. It is also important to remember that soil health changes slowly over time (on the order of several years to decades).

Cornell Soil Health Test Report Field Management Sheet

Step 1. Identify constraints, prioritize **Identified in the Soil Health Report**	*Low aggregate stability (poor soil structure)* *Low organic matter (low energy/C storage, low water retention)* *Low Active C (hungry soil food web)* *Low PMN (low biological activity)*
Step 2. List management options **Some suggestions found in Table 5 (page 52)**	*Add/ grow fresh organic matter* *Add stable organics (composts, biochar)* *Reduce tillage intensity, Rotate with shorter season crop* *Find window for shallow-rooted cover crop*
Step 3. Determine site history/ farm background **Note here any situational opportunities or limitations**	*Far from dairy farm, Short growing season* *Soil "addicted to tillage"* *Diverse inventory of field equipment* *Grower willing to "try anything"*
Step 4. Management Strategy 2010 **The agronomic science of Steps 1 and 2 combine with the grower realities of Step 3 to create Field Management Plan**	*Drill barley/ timothy/ clover mix in spring* *Harvest barley, Mow timothy/ clover as green manure* *Fall mow, rent ripper for strip till for corn 2011* *Learn about strip tillage* *(Build soil for transition to strip till)*

Figure 2. Completed management decision worksheet for the CSHT report in Fig. 2.

We have developed a four-step process to help growers (often in collaboration with their extension educators or consultants) to make management decisions that will help alleviate soil constraints identified in their CSHT report. Fig. 2 shows an example of this process. The grower, in Step 1, lists the constraints identified in the CSHT report (Fig. 1) and then, in Step 2, lists potential management options for those constraints. Examples of such options, such as those listed in Fig 2, Step 2, can be found on page 52 of the Cornell Soil Health Assessment Training Manual (available online, see below). For example adding or

growing fresh organic matter and reducing tillage will both improve low aggregate stability and low biological activity. The grower then, in Step 3, considers relevant opportunities (such as having access to diverse equipment, and being willing to try anything) and limitations (such as being far from a dairy farm, and thus having no access to manure, etc) of the farm and field. Combining the agronomic science (Steps 1 and 2) with the realities on the ground (Step 3), the grower can then create short- and/or long-term field management plans that will be feasible on that field. An interactive small-group activity will follow our presentation, in which we will guide participants through this process with several examples.

3. Relationship of CSHT Measures to Yield in Kenya

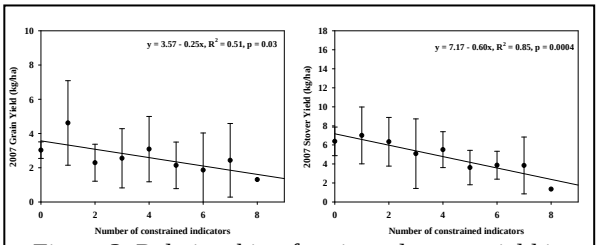

Figure 3. Relationship of grain and stover yield in western Kenya smallholder farms to number of indicators found to be constrained in a CSHT.

In a study in western Kenya's smallholder systems, we showed that indicators of the CSHT were sensitive to agricultural management and to degradation effects of cultivation over time, and that it was useful for informing management decisions. We also showed that CSHT measures were strongly related to crop yield components. Fig. 3. shows that with an increasing number of constrained indicators, corn grain yields decreased.

4. Sample Submission in 2011

a. Comprehensive CSHT analysis cost will cost $75/sample in 2011, while the basic test (that does not include the potentially mineralizable nitrogen and root health assays) will cost $45/sample. Sampling info and submission sheets available at **http://soilhealth.cals.cornell.edu.**
   i. NYS growers will receive CNAL recommendations within about 10 days.
   ii. Growers will receive a CSHT Report within about 6 weeks.

b. Sample submission is simple – **no more mailing hassles**! Sample delivery to Cornell is free via our collaboration with DAIRY-ONE. To find the closest pick-up point to you, go to **http://www.dairyone.com/AgroOne/sample_pick_up_points.htm**.

5. Trainings, Manual, and Other Material

a. Manual – the second Edition of Cornell Soil Health Assessment Training Manual is available on our website **http://soilhealth.cals.cornell.edu**

b. Trainings – Mark your Calendars: March 23, 2011, 1-day workshop on Cornell Soil Health Test report interpretation and Adaptive N Management. For info or to register, see our website.

c. Another good reference is the new edition of the book "Building Soils for Better Crops" by Fred Magdoff and Harold van Es. It can be downloaded for free from the SARE website http://www.sare.org/publications/soils.htm